# ENERGY CONSERVATION STRATEGIES IN THE CONTEMPORARY SRI LANKAN HIGH-RISE BUILDINGS WITH SPECIAL REFERENCE TO FORM AND ORIENTATION

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## DECLARATION

I declare that this dissertation represents my own work, except where due acknowledgement is made, and that it has not been previously included in a thesis, dissertation or report submitted to this university or to any other institution for a degree, diploma or other qualification.



... U.K.P. Arachchi ...

(U.K.Perumpuli Arachchi)

# Abstract

This study is focused on the Energy Conservation Strategies of the contemporary high-rise buildings in Sri Lanka with special reference to the building form and the orientation.

In the future energy becomes a more important factor because there are limited resources, which can be used to generate energy. The huge component of the generated energy used by the commercial buildings (30%) and they have to pay huge sum of money for that. Therefore it's important to study the energy conservation methods, which can be used in every stages of built environment.

In this study selected current multi-storey office buildings, which are located in urban context (Colombo) and from that identified average requirements for 'typical multi storey building' space including equipments and occupants. That 'typical space' and requirements arranged into five different forms of models (computer generated) and tested them for different orientations.

From the cooling load calculate the energy requirement in different stages and from that identified the most suitable conditions for Sri Lankan urban context. In conclusion recommendations have been made for a better and suitable Architectural Form of high-rise building and suitable Orientation for Sri Lankan urban context.

# Acknowledgement

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# Introduction

**Topic Explanation**

Changes in energy supply and energy source have the most profound effect on building design and urban form since the beginning of the industrial revolution. During most of the last century, architects and engineers have designed buildings free of the natural constraints out of which all-great architectural springs. Chances are that buildings now on designing stage or in construction stage will still be standings at least in the next fifty years from now on and therefore it should be suitable for the future in every ways.

When considering about ~~the~~ energy consumption patterns and the amount, large part of the energy is consumed by the commercial buildings of the urban context. Also considerable amount of energy is used by high-rise commercial and office buildings (non domestic buildings) when compared with domestic and public requirements.

The energy consumption of the building is very important because the resources such as hydropower, coal, fuel, nuclear power, gas... etc that can use to produce energy is limited in the world and spread in certain places of the world.

The major problem of this was the poor countries, which haven't fossil fuel or huge capital and facility to produce other energy producers such as nuclear power, should expend large amount of money every year for energy production. It will badly affect the country because they spend the money for energy, which can be used for the development of the country.

In the next two or three decades the high-rise and medium-rise buildings cover considerable range of the urban lands to complete human day to day requirements because the limited land remaining in urban context. Also those buildings need high amount of energy to create and maintain the comfortable microclimate inside them. To arrange good environment inside the building all the components such as temperature, humidity, lighting level... etc have to be controlled artificially because in the present and in the future the outside environment was not at comfortable level.

Architects have great responsibility about the energy consumption of the buildings because architecture is a complex involving of technical, social, utilitarian, cultural and as well as energy conservation of built environment. If the architect didn't consider about the energy consumption patterns of the building the company or the

client who own the building will have to pay large amount of money for energy consumption in every month.

According to the research of California university, they show that new building could be designed to current standards of comfort, use and economy and make full use of the potential of renewable resources such as solar energy, as well as conserving existing fossil fuels. They also design energy efficient office building by discovering that through a careful orchestration of techniques – including reduction of unnecessary lighting levels, careful attention to orientation and the shape of the building and other techniques compatible with the specific microclimate. Finally they found that building consume less than 20% of the energy used by buildings built few years ago.

( Watson,D: 1977)

The below chart percentages show approximate energy consumption of the high-rise buildings in Sri Lanka urban context.

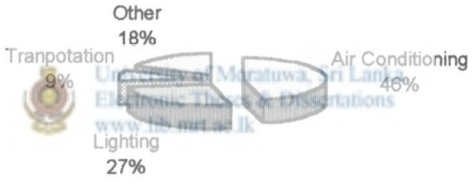






Fig. 1 Energy Consumption in High-rise Buildings

According to above data 80 % of energy used for air conditioning and artificial lighting requirements of the building. Therefore its more important to study the energy consumption patterns for the artificial lighting and air conditioning the building and what are the possible ways which can reduce the energy consumption for those items. In Sri Lankan climate more than 300 days are sunny days and consequently considerable amount of energy, which use for artificial light can reduce very easily by using the natural light for office activities.

For that its very important to consider the different aspect deeply such as the shape of the building, orientation of the building, wall areas faced to direct sunlight and their external texture, external wall colour and reflectance quality of those wall material, window arrangements the type of glass use for windows and their positions … etc. at

the early designing stage as well as the construction stages until completion the building.

**Architectural Problem / Issue**

Today most of the designers/ Architects aren't considering the form of the building and orientation related to the energy consumption of the building. They consider the elevation or the skin of the building only related to create attractive appearance because present day they were not much responsible about the amount of energy consumption by that building when it functions. According to above explanation the energy efficient building becomes one of the most important concepts in the future and the Architects should give grate consideration about that reason. When designing an energy efficient high-rise building without destroy the thermal comfort of the user, appropriate (ideal) standards could be obtained; thereby the study could guide designers to produce energy efficient high-rise building at the same time pay adequate consideration to user comfort.

**Justification**



In present days the outdoors temperature increases up to very uncomfortable level and as a result most of the commercial and office buildings use air-conditioning systems to create comfortable microclimate in side the building. Consequently those buildings use high amount of energy for air-conditioning (ventilation) and lighting to maintain their microclimate inside them. The aim of the study is to analyse how the building shape and orientation can use to create energy efficient building without destroying the comfortable microclimate of the high-rise buildings. It is true that the energy consumption for artificial lighting in daytime and air-conditioning is not a big fraction of the total consumption of the country's energy consumption in present day. But in the future this matter can be a huge problem (the energy consumption in high-rise buildings) if we don't considers this today. Also the energy is expensive and awareness of energy saving at each level has become more important in present day as well as in the future. The Architect is no exception and he should do his part towards energy saving. Since there is no doubt that the study of this section is timely and worth studying for the present day and for the future designs.

**Objectives**

- Analyse the selected aspects of the orientation and the shape of the high-rises which suitable to Sri Lanka
- Formulate appropriate standards and suggestions for the high-rises, which can apply in the designing stage.
- Guidelines for designers (Architects) to create an energy conscious design (buildings).

**Limitations**

- All types of high-rise buildings could not be analysed as a simulation is carried
  out for hypothetical high-rise building.
- The study is concentrated for only five shapes of high-rise building types.
- The study is concentrated on air-conditioned high-rise buildings only.

The results and discussions are based on DEROB computer program simulations and the limitations of this software are also to be considered.



**Methods of Study**

Two different shapes of high-rise buildings (air-conditioned) in Sri Lanka have been identified and analysed their energy consumption pattern. After that creates them as computer-programmed models and analyse their energy consumption when change the orientation remaining same comfortable limitations.

Likewise various shape of high-rise building models simulated by the computer analyse their energy consumption patterns in different orientations. From that identify the most suitable shape and orientation of the high-rise building for Sri Lankan context.